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(54) Apparatus and method for application of liquid to web or sheet material.

(57) Accurately predetermined quantities of liquid can be applied from a plurality of needle-like or capillary jets (17) to web or sheet material (14) which is moving continuously relative to said jets. The liquid is supplied to the jets (17) at superatmospheric pressure via respective electromechanical valves (20), which are controlled by computer to open and close rapidly so that discrete droplets of liquid are fired from the jets (17) in a succession of short pulses each of a duration of 0.5 to 15 milliseconds, and with a frequency of 50 to 500 Hz. Thus, small quantities of treatment liquids can be uniformly applied and, in specific cases where the liquid is colouring medium, pre-programmed patterns can be applied in simple and effective manner.

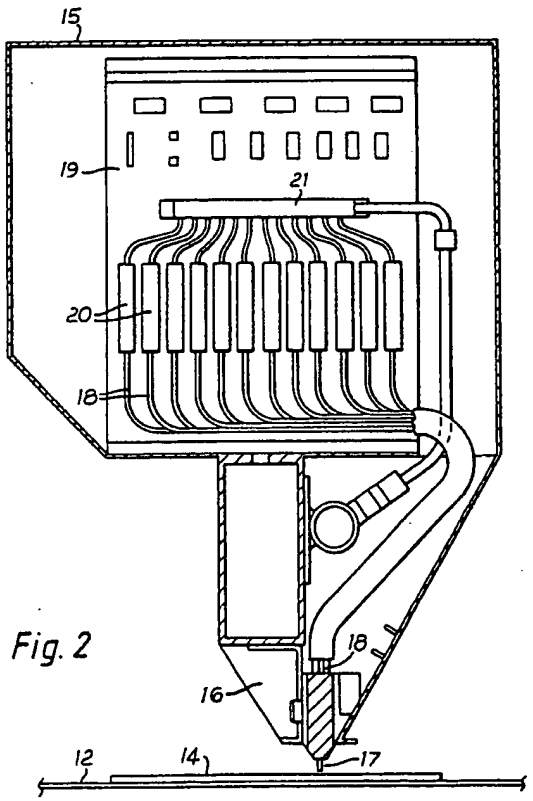

Fig. 2

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APPARATUS AND METHOD FOR APPLICATION OF LIQUID TO WEB OR SHEET MATERIAL

This invention relates in general, to the application of liquid to web or sheet material.

More particularly the invention is concerned with a method of and apparatus for patterning material, for example woven or tufted web material, such as carpet fabric which may be cut-pile, looped pile, tufted or other fabric, sheet material elements, such as carpet tiles or like pieces, felt, woven or non-woven textiles, paper, board, film, coated or non-coated webs, and all similar or comparable sheet materials, either in continuous lengths or in individual pieces.

As hitherto proposed, the patterning of web material, particularly pile material, has been effected in a complex manner and involved complicated apparatus. Rows of jets supplied with colour medium have been provided in dispositions so as to be directed towards the material which is progressed therepast. In one form of known apparatus each such jet has an associated deflector air jet which is controlled by a respective electromechanical valve from a suitable mechanism (such as a pattern reader) in such a way that a stream of air deflects the stream of colour medium issuing from its respective colour jet into an adjacent receiving trough whenever the colour medium is not required to be applied to that particular place on the material. Of course, whenever the colour medium is required to be applied to the material, the electromagnetic valve is closed so that the stream of colour medium can impinge on the material. The eventual design produced upon the material is thus determined by the pattern reader or like mechanism switching the air jets on and off as appropriate.

In another known form of apparatus, the material to be patterned is moved intermittently past the rows of jets, while the jets themselves are moved transversely across the material, whenever the latter stops, and are caused to apply colour medium to the material only at positions predetermined by a pattern control mechanism.

Both types of known apparatus are complicated in their construction and also expensive.

An object of the invention, in general terms, is provision of apparatus and a complementary method for the application of liquids to web or sheet material, having the advantages of permitting accurately predetermined or precise quantities of liquid to be applied to the material. Such apparatus and method would be capable of being employed, for instance, to apply very small quantities per unit area, to provide for instantaneous variation of the quantity supplied at any time, if so desired, to apply a liquid to a material which is already wet, and/or for double-sided application of liquid, i.e. the application of one liquid to one side or face of the material and the application of the same or another liquid to the other side or face of the material, the invention enabling consistency and uniformity of application of the liquid, even though quite wide areas may be involved.

A more specific object of the present invention is to provide an arrangement whereby web or sheet material, such as carpet fabric in the web or in the form of tiles, may be printed with patterns or designs in a simple, efficient and versatile way which does not involve the initiation and switching-off of air jets, which enables sharply-defined patterns and /or designs to be produced and which is versatile in its operation in that it can be employed, in appropriate constructions, to enable a very wide range of different designs or patterns to be produced.

With these objects in view, the present invention provides apparatus for applying liquid medium to web or sheet material comprising a plurality of jets each supplied with liquid medium at superatmospheric pressure and each controlled by a respective electro-mechanical valve, means for causing relative movement between material required to have liquid applied thereto and the jets with the latter orientated towards the material, and programmable control means to control the valves for the liquid medium to be applied to the material in predetermined quantity from each jet, characterised in that the jets are in the form of hollow needles or capillary tubes which have a bore diameter of from 0.2 to 2mm and which operate to fire discrete droplets of liquid medium in a succession of pulses each of a duration in the range from 0.5 to 15 milliseconds.

The invention further provides, of course, a method of applying liquid medium to web or sheet material, which method comprises causing relative movement of said material past a plurality of je's in the form of hollow needles or capillary tubes having a bore diameter of from 0.2 to 2mm, with the jets orientated towards the material, supplying liquid medium to the jets at superatmospheric pressure by way of respective electro-mechanical valves, and controlling the valves with programmable control means to open and close again rapidly so that each jet operates to fire discrete droplets of the liquid medium in a succession of pulses each of a duration in the range from 0.5 to 15 milliseconds.

Thus, the apparatus of th invention supplies intermittent pulses of liquid, i.e. short pulses corresponding to periods when the valves are open,

with gaps therebetwe n corresponding to periods when the valves are closed, the valves being capable of opening and closing again very rapidly so that a succession of such pulses arises.

In accordance with the invention, th apparatus and method can be operated, as desir d, to apply fluid medium to one or both sides of the material to be treated in predetermined amounts over predetermined areas, which may comprise the entire area of the material when it is desired to apply a treatment liquid to the entire material, or may comprise only selected areas.

Non-exhaustive examples of practical uses where the entire area of material may require to have a liquid medium applied thereto are:

(a) the application of textile finishing agents (e.g. crease-resistant agents, sheen-imparting agents, anti-static agents) to one or both sides of a woven, knitted or bonded fabrics;

(b) the application of dyes to fabrics;

(c) the application of surface coatings, or impregnating coatings, to fabrics, non-woven sheet material, paper, carpet fabric and the like;

(d) decorative application of liquids such as plastisols to non-porous sheet material or web.

A practical instance where the jets are actuated to apply treatment liquid only over selected areas of the material is, of course, in the production of predetermined patterns or designs upon web or sheet material. In such a case, the liquid medium supplied to the jets is colouring medium and the programmable control means is effective to control the valves in such a way that the colouring medium is applied to the material from the jets according to a predetermined pattern or design.

In all cases the jets operate to fire the liquid or colouring medium as discrete droplets.

For ease of construction and operation, the arrangement is preferably such that the jets are stationary and the means for causing relative movement comprises conveyor means which serves continuously to convey the material to be treated (e.g. patterned) past (e.g. below) said jets.

In an elementary construction of apparatus specifically adapted for application of patterns there may be, for instance, just a single row of the jets. These may all be supplied with liquid colouring medium (e.g. dye solution) of one colour, e.g. from a single manifold, or they may be arranged to be supplied with different colouring media, for instance in adjacent or separated groups. Obviously where only a single colour is employed, patterns only in that colour are produced. The use of different colours supplied to different jets enables patterns to be produced in different colours, of course. However, the distribution of the colours across the material will, then, be restricted.

To permit variation of the colour distribution across the material width, the apparatus of the invention preferably includes a plurality of rows of jets, each row extending transversely of the path of the movem nt of the material, and each row conveniently being supplied with its own respective colour medium, e.g. from a respective common manifold.

The jets each comprise a respective hollow needle or capillary tube, and each row of such jets may be provided on or through a respective carrier bar, being supplied with colouring medium by way of a respective flexible tube from its manifold, a housing, casing or the like being provided as a bridge across the path of the material for accommodating the bar. Then, the manifold or manifolds for said row, together with the respective electromechanical valves, may advantageously be mounted on a respective printed-circuit-type mounting board which can be plugged in place, by inserting it also into the same housing, casing or the like, to provide connections between the valves and the programmable control means, e.g. computer. This arrangement makes it very simple to enable a manifold, its row of needles, and its respective valves, to be removed, by unplugging, for easy replacement, for example for maintenance or in the event of the occurrence of faults preventing correct pattern printing.

The apparatus of the invention may advantageously form a component of a carpet material or tile printing or patterning line which comprises, for instance, means for supplying the material in a web or as tiles to the apparatus, and subsequent colour fixing apparatus.

The apparatus may, for instance, be modular, each module comprising its own row of colour jets for a respective colour, so that a module will be provided for each colour required to be printed in the pattern or design.

Within the scope of the invention, the apparatus and method referred to in the preceding paragraphs may, of course, be appropriately modified for forms of liquid treatment other than application of coloured patterns, for example application of finishing agents or surface coatings to web or sheet material as mentioned above.

The invention will be described further, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic perspective view of a practical embodiment of apparatus in accordance with the invention for production of patterned carpet tiles;

Fig. 2 is an enlarged scale cross-section through a casing incorporating a row of jets at one of the patterning stations of the apparatus shown in Fig. 1;

Fig. 3 is a schematic diagram illustrating how a particular pattern programme is achieved and carried into effect with the apparatus shown in Fig. 1; and

Fig. 4 is a diagrammatic side elevation of a modified embodiment of apparatus in accordance with the invention for application of other liquid treatment media to web material.

Referring firstly to Fig. 1, an exemplary practical embodiment of the apparatus of the invention is in the form of a production line having, in succession, a tile feed station A, a plurality of design or pattern-applying stations B, C, D, and a tile take-off station E.

A structural framework, including side panels 10, support a plurality of guide rollers 11 for an endless conveyor belt 12, which extends from end to end of the production line and the upper run of which is in a substantially horizontal disposition and, in the main, is exposed from above. The roller 11 at the take-off station E is driven by a motor 13 to effect continuous movement of the belt 12, and naturally the arrangement is such that successive tiles 14 (e.g. pile-surfaced carpet tiles) to be patterned are placed on the upper run of the conveyor belt 12 at the tile feed station A, either by hand or from an automatic supply mechanism (not shown).

Each of the design or pattern-applying stations B, C, D is substantially identical, so it is only necessary to describe one of them, for instance the first of them, with particular reference to Fig. 2. At this pattern applying station B, a casing 15 is supported in bridge-like disposition across the belt 12. The construction of this casing 15 is generally rectangular both in plan and elevation in its upper part, but at its lower part it tapers in elevation so as to provide a narrow downwardly-open mouth extending transversely across the conveyor belt 12, from side to side thereof.

Accommodated in the lower part of the casing 15 is a jet carrier in the form of a metal or plastics bar 16 connected to a plurality of downwardly-projecting colour jets which are in the form of narrow hollow needles or capillary tubes 17. The jets 17 are arranged parallel to one another in a row extending substantially from end to end of the bar 16, the spacing of the jets 17 being selected according to the fineness of the liquid stream which has to be produced (dependent on the sharpness of the desired eventual pattern) with the maximum number of such jets and the fineness thereof being limited by practical considerations. A typical range of spacings is from 4 to 40 per inch (2.5cms) with tube or capillary bore from 0.2mm to 2mm in diameter.

A flexible (e.g. translucent plastics) tube 18 is connected to ach jet 17 and there tubes 18 extend, as a bundle, to a board 19 which is accommodated by its edges in guides in th upp r rectangular part of the casing 15. Mounted on the board 19, there is for ach jet 17 a respective electromechanical on/off valve 20 which is capable of being switched on and off at a very high frequency (e.g. in the range 50 to 500 Hz) and is disposed in the respective flexible tube 18 subsequent to the latter being connected to a manifold 21, which is also mounted on the board 19 and is supplied with a respective colouring medium, such as a solution of quick setting dye. Leads from the valves 20, formed. for instance, as printed circuits on the board 19 extend via ancillary transistorised circuits to edge terminals on the board 19 so that when the latter is slid into place in its casing 15 such terminals plug into respective pinch-type sockets which in turn are connected to a prograr.mable control e.g. in the form of a computer. It should be understood that there needs to be only a single such computer to control all of the pattern applying stations B, C and D.

At the subsequent take-off station E the upper run of the belt 12 is accessible for tiles 14 thereon to be removed, e.g. by hand or by a suitable take-off mechanism (not shown).

The mode of operation of the apparatus will readily be understood from the foregoing description. Initially, the computer 30 is programmed according to the pattern or design required to be applied to each tile, as indicated schematically in Fig. 3. In this respect, the parameters of the chosen design are input to the computer 30 either directly from a colour monitor 31 or via a graphic control unit 32 and auxiliary computer 33. If appropriate the necessary design information can be stored on a floppy disc 34 and thus input to the computer 30 again when needed.

Respective colouring medium is supplied under pressure to the manifold 21 of each of the design or pattern-applying stations the valves 20 are at this stage closed. The conveyor belt 12 is then put into motion. Each such colouring medium is supplied, for instance, from a respective pressurised container 35 connected to the manifold and under pressure, for instance in the range of 0.3 to 3 bar.

Successive tiles 14 are now positioned on the conveyor belt 12 at the tile feed station A and when the first of these reaches the first pattern-applying station B an appropriate signal is supplied (e.g. from a photo-electric or mechanical sensor) to initiate operation of the computer 30 which opens and closes the or each of the respective valves 20 in accordance with the preprogrammed pattern or design to apply clearly defined areas of the respective colour to the tile 14 passing through. Each jet 17 is thus caused to fire its dye solution onto the confronting surface of the passing tile 14 in short

pulses of droplets. Such pulses are each of a duration in the range of 0.5 to 15 milliseconds, the duration being varied to match other parameters, such as the pressure of the colouring medium, the viscosity thereof, the speed of passage of the material being printed, and the extent of the area desired to be covered by each pulse.

The same applies at each of the subsequent pattern-applying stations C, D whereat areas of different colours are applied successively until the entire desired pattern or design (which may cover the entire pile surface of the tile 14 or leave some of the basic surface thereof unprinted with colouring medium) has been built up. The tile 14 eventually emerges at the last of the pattern-applying stations D and is transported to the take-off station E, where it is removed. Thereafter it may dwell or be subjected to a colour setting process, if desired.

The apparatus of the invention is, of course, very simple, convenient, and relatively uncomplicated in comparison with the known arrangements for achieving comparable results. It has the particular advantage that it can produce very sharply defined patterns and designs very easily and conveniently, and the cost of the apparatus is very much less than anything hitherto proposed. Moreover it can run faster, producing, for instance, as many as ten to twenty patterned tiles per minute, with very accurate registration of the pattern or design with respect of the edges or sides of the tiles, and reliable reproducibility.

Although in the foregoing specific description the invention has been described in connection with a production line for producing patterned carpet tiles each of a predetermined and constant pattern, it is not limited solely hereto, and it will be obvious to those skilled in the art that it can be used for the application of designs or patterns to any kind of sheet material whether in continuous web form or in the form of individual or discrete pieces. Moreover, the apparatus and method can be readily modified and adapted for application of predetermined quantities of any type of liquid medium, such as a finishing liquid, to web or sheet material, and the liquid can be applied to one or both surfaces of the material and either to the entire surface or only parts thereof, as desired.

Fig. 4 illustrates one example of such modified apparatus which is used for application of a finishing liquid to the entire surface of one side of a web 42 of textile fabric. In similar manner it is in the form of a production line having, in succession a web feed station A, a plurality of liquid-medium applying stations B, C, D, one or more drying or setting stations F, and a web take-off station E. Instead of a conveyor belt being provided, the web 42 to be treated is itself directly supported upon a plurality of guide rolls 41 and extends from end to end of the production line in a substantially horizontal disposition so that in the main it is exposed from above. At the take-off station E a pair of driven nip rollers 43 draw the web 42 through and supply it to a take-up real 44 and naturally the arrangement is such that, at the web feed station A, a supply roll 45 of the web is located so as to pay off its web 42 to the first of the liquid-medium applying stations B.

Excepting for provision of the drying or setting station F, the remaining construction of the apparatus illustrated in Fig. 4, and its operation, are substantially as described in relation to the embodiment shown in Figs. 1 to 3. The liquid applied may, for example, be a solution of a quick curing crease-resistance-imparting polymer.

Other variations are, of course, possible within the scope of the invention.

Claims

1. Apparatus for applying liquid medium to web or sheet material (14) comprising a plurality of jets (17) each supplied with liquid medium at superatmospheric pressure and each controlled by a respective electro-mechanical valve (20), means for causing relative movement between the material required to have liquid applied thereto and the jets (17) with the latter orientated towards the material (14), and programmable control means to control the valves (20) for the liquid medium to be applied to the material (14) in predetermined quantity from each jet (17), characterized in that the jets (17) are in the form of hollow needles or capillary tubes which have a bore diameter of from 0.2 to 2mm and which operate to fire discrete droplets of liquid medium in a succession of pulses each of a duration in the range from 0.5 to 15 milliseconds.

2. Apparatus as claimed in claim 1 for use in producing a pattern or design upon web or sheet material, wherein the liquid medium supplied to the jets (17) is colouring medium and the programmable control means is effective to control the valves (20) in such a way that the colouring medium is applied to the material (14) from the jets (17) according to a predetermined pattern or design.

3. Apparatus as claimed in any preceding claim wherein the jets (17) are stationary and the means for causing relative movement between the material (14) and the jets comprises conveyor means (12) which serves continuously to convey the material past the jets.

4. Apparatus as claimed in any preceding claims wher in the jets (17) are arranged as one or more rows extending transversely of the direction

of relative movement between the material (14) and the jets, and ach row of jets is supplied with liquid medium from a respective manifold (21).

5. Apparatus as claimed in claim 4 wherein each row of jets (17) is provided on or through a respective carrier bar (16), which is accommodated within a housing, casing or the like (15) provided as a bridge across the path of the material (14).

6. Apparatus as claimed in claim 5 wherein the manifold (21) for each row of jets (17), together with the respective electro-mechanical valves (20), is mounted on a respective printed-circuit-type mounting board (19) which can be plugged in place, by inserting it into the housing, casing or the like (15), to provide connections between the valves (20) and the programmable control means.

7. Apparatus as claimed in any of claims 4 to 6 wherein the jets (17) in each row are arranged at a spacing in the range of from 4 to 40 per inch (per 2.5 cm).

8. Apparatus as claimed in any preceding claim wherein the electro-mechanical valves are capable of being opened and closed at a frequency in the range of 50 to 500 Hz.

9. A method of applying liquid medium to web or sheet material (14), which method comprises causing relative movement of said material (14) past a plurality of jets (17) with the jets (17) orientated towards the material, supplying liquid medium to the jets at superatmospheric pressure by way of respective electro-mechanical valves (20), and controlling the valves with programmable control means, characterised in that the jets (17) are in the form of hollow needles or capillary tubes having a bore diameter of from 0.2 to 2mm, and in that the programmable control means causes the valves to open and close again rapidly so that each jet operates to fire discrete droplets of the liquid medium in a succession of pulses each of a duration in the range from 0.5 to 15 milliseconds.

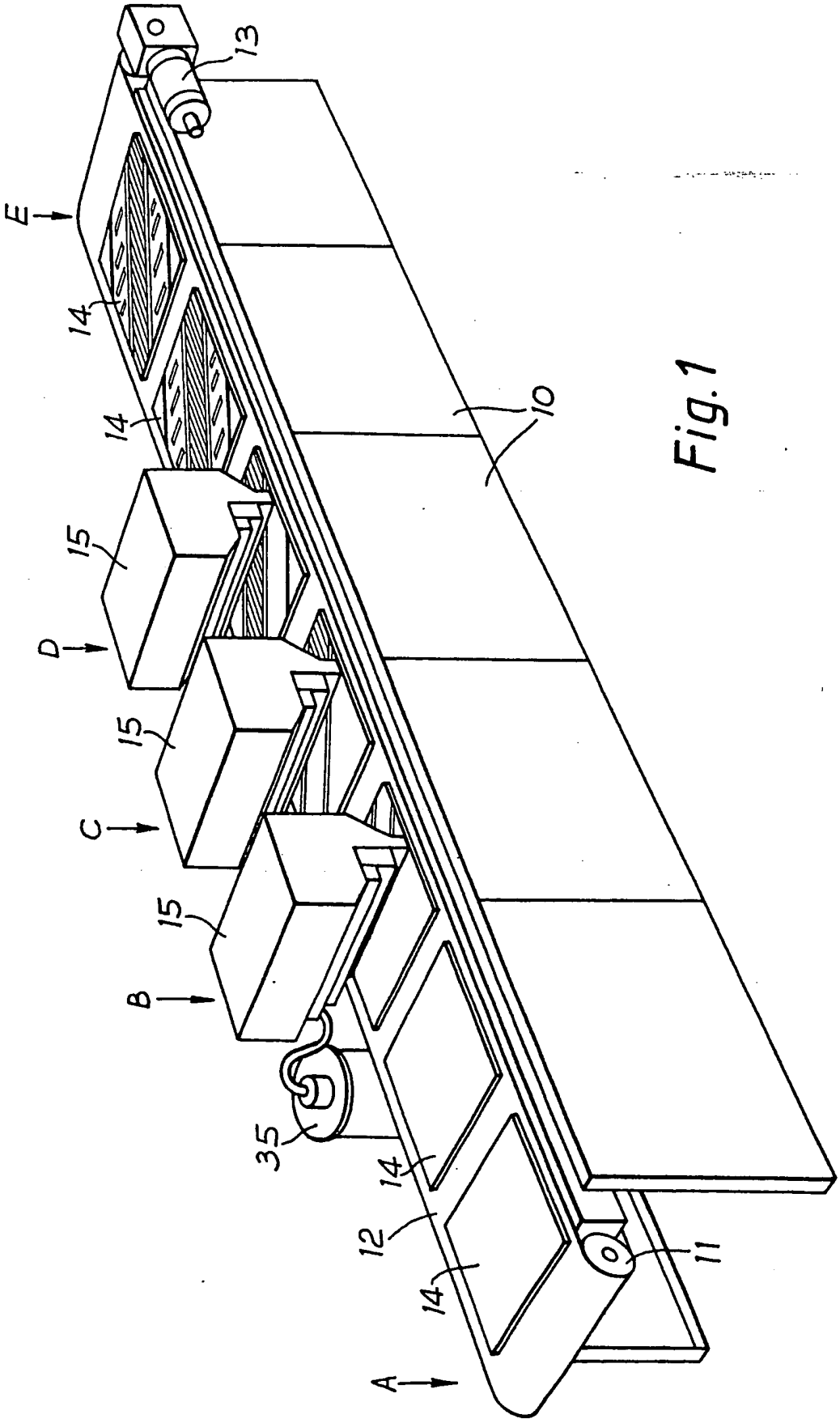

Fig.1

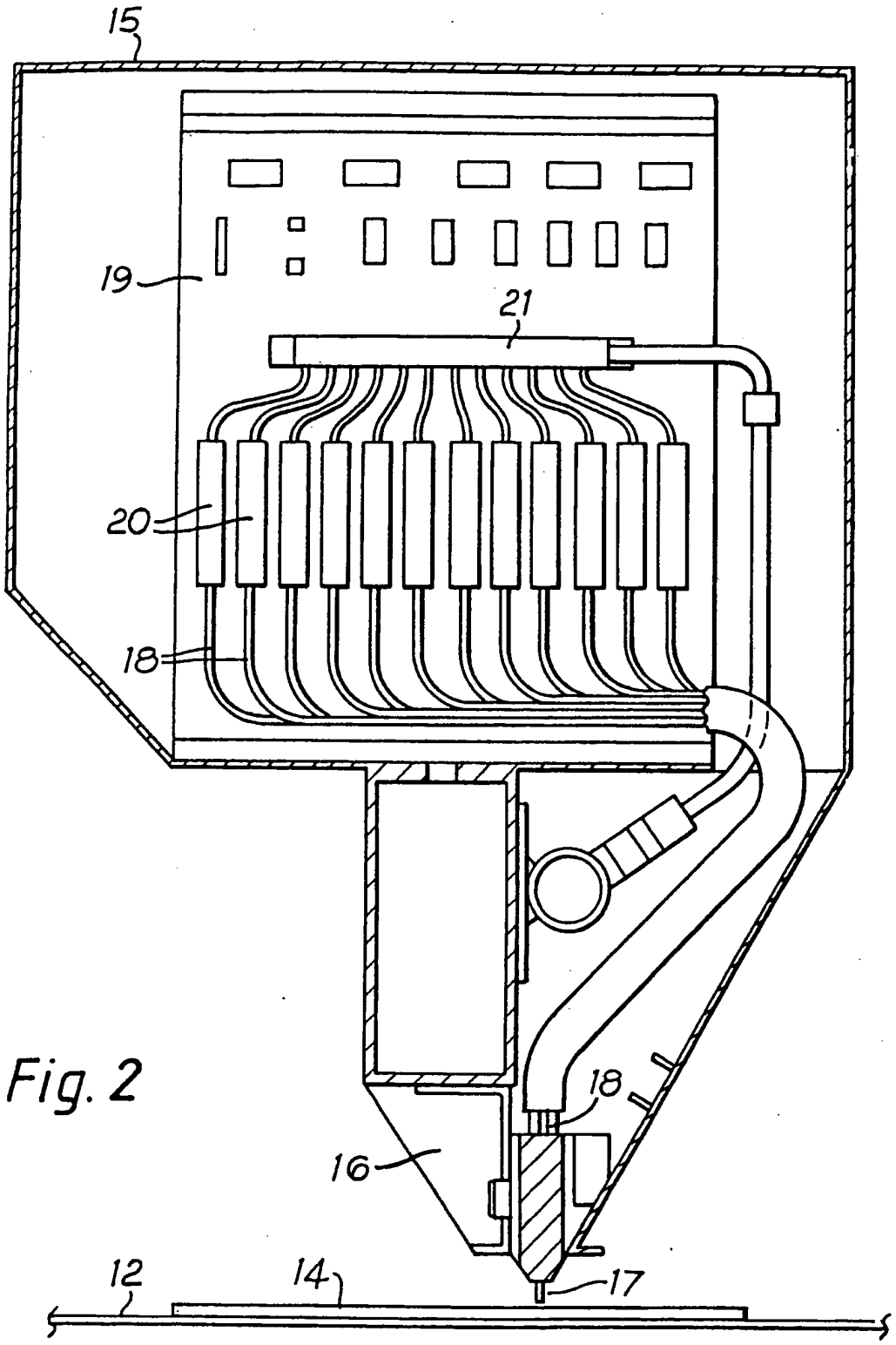

Fig. 2

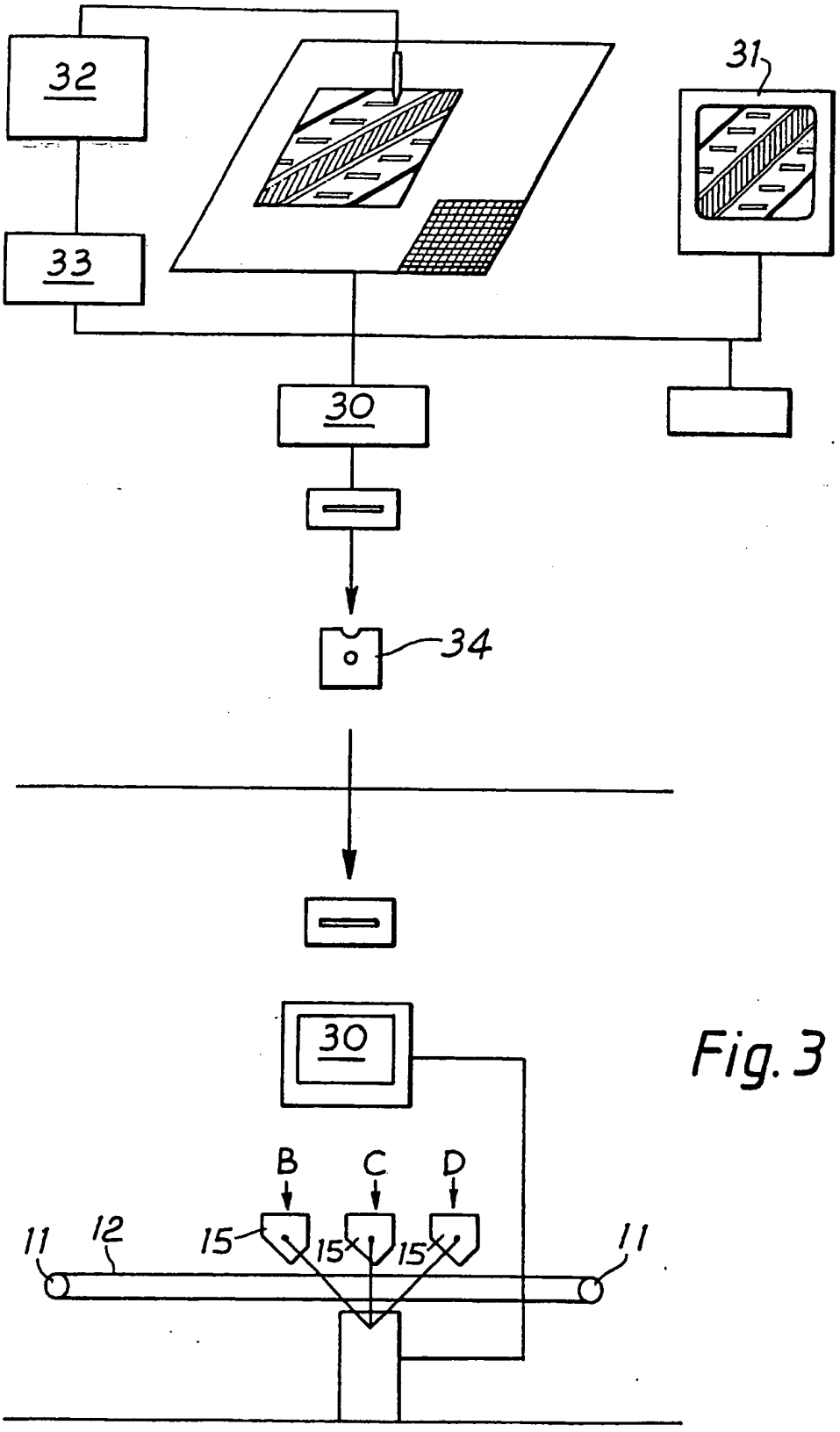

Fig. 3

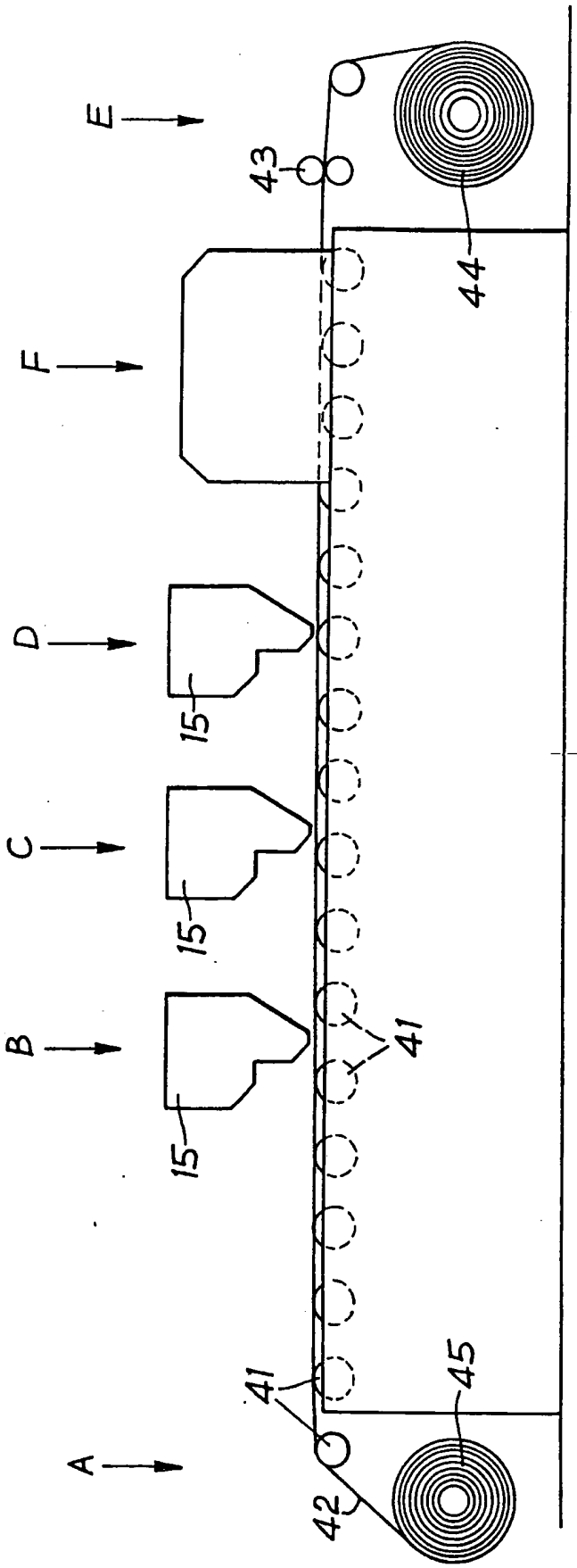

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number

EP 87 30 7872

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	GB-A-2 022 017 (TYBAR) * Whole document; claim 1; page 6, lines 3-17 *	1-7,9	D 06 B 1[illegible]/00
X	WO-A-8 101 161 (OTTING) * Whole document *	1-7,9	
A	FR-A-2 271 878 (DEERING MILLIKEN) * Whole document *	1,8	
A	US-A-4 170 883 (MILLIKEN RESEARCH)		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

D 06 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	09-05-1988	PETIT J.P.

CATEGORY OF CITED DOCUMENTS

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